

SCORING ASSESSMENT OF REGIONAL MATERIALS FOR GREEN  
HIGHWAY

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“The roots of education are bitter, but the fruit is sweet” – **Aristotle**

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## **ABSTRACT**

The objectives of this study are to identify the criteria of regional material which is divided into two sub-criteria, local material and earthwork balance, to determine the score value for the criteria and to find the relevancy in applying them in Kuala Lumpur. The method used in data collection is through questionnaires survey given to 47 respondents from 13 highway companies in Kuala Lumpur. SPSS software was used to analyse the data. The scores for the criteria were determined by computing the average index value. The results showed an index score of 3.851 and 3.936 for local material and earthwork balance respectively which indicate that the results are significant. However, the data obtained are not sufficiently reliable to predict the agreement level as the results from regression analysis showed low values of  $R^2$  of 0.143 and 0.041 for agreement towards local material and earthwork balance respectively. 11 out of 13 companies (84.61%) supported the usage of regional material as one of the criteria contributed to green highway

## ABSTRAK

Objektif kajian ini adalah untuk mengenal pasti kriteria bagi *regional material* yang dibahagikan kepada dua sub-kriteria, bahan tempatan dan kerja tanah, yang digunakan untuk menentukan nilai skor untuk kriteria tersebut dan untuk menentukan kesesuaian penggunaan bahan tersebut dalam pembinaan lebuh raya hijau di Kuala Lumpur. Kaedah yang digunakan dalam pengumpulan data adalah melalui cara soal selidik yang diberikan kepada 47 orang responden daripada 13 syarikat lebih raya di Kuala Lumpur. Perisian SPSS telah digunakan untuk menganalisis data. Markah skor untuk kriteria ditentukan dengan kaedah pengiraan nilai indeks purata. Hasil kajian menunjukkan skor indeks masing-masing 3.851 dan 3.936 untuk bahan tempatan dan baki kerja tanah yang menunjukkan bahawa kajian ini memberi keputusan yang memuaskan. Walau bagaimanapun, data yang diperolehi tidak mencukupi untuk meramalkan tahap persetujuan responden kerana hasil daripada analisis regresi menunjukkan nilai  $R^2$  yang rendah iaitu 0,143 dan 0,041 untuk bahan tempatan dan baki kerja tanah. 11 daripada 13 syarikat (84.61%) menyokong penggunaan *regional material* sebagai salah satu kriteria yang menyumbang kepada lebuh raya hijau.

## TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	<b>DECLARATION</b>	<b>ii</b>
	<b>DEDICATION</b>	<b>iii</b>
	<b>ACKNOWLEDGEMENT</b>	<b>iv</b>
	<b>ABSTRACT</b>	<b>v</b>
	<b>ABSTRAK</b>	<b>vi</b>
	<b>TABLES OF CONTENTS</b>	<b>vii</b>
	<b>LIST OF TABLES</b>	<b>xi</b>
	<b>LIST OF FIGURES</b>	<b>xii</b>
	<b>LIST OF SYMBOLS</b>	<b>xv</b>
	<b>LIST OF APPENDICES</b>	<b>xvi</b>
 <b>1</b>	 <b>INTRODUCTION</b>	
	1.1 Introduction	1
	1.2 Background of Study	2
	1.3 Objectives of Study	3
	1.4 Scope of Study	3
	1.5 Importance of Study	4
 <b>2</b>	 <b>LITERATURE REVIEW</b>	 <b>5</b>
	2.1 Introduction	5
	2.2 Green Highway Concept	5
	2.3 Rating System	8

2.3.1	Leadership in Energy and Environmental Design (LEED)	8
2.3.2	Greenroads	9
2.3.3	GreenPave	11
2.3.4	Green Guide for Roads	12
2.3.5	Leadership In Transportation and Environmental Sustainability (GreenLITES)	13
2.3.6	Green Building Index (GBI)	14
2.4	Regional Material	15
2.4.1	Locally Sourced Material	15
2.4.2	Earthwork Balance	18
2.5	Conclusion	19
<b>3</b>	<b>METHODOLOGY</b>	20
3.1	Introduction	20
3.2	Process of Study	20
3.3	Data Collection	22
3.3.1	Main Data	22
3.3.2	Questionnaires	23
3.3.3	Subject of Study	24
3.4	Statistical Package for the Social Science (SPSS)	24
3.4.1	Feature of SPSS	24
3.4.2	How SPSS Work	25
3.5	Data Analysis	28
3.5.1	Average Index Value	28
3.5.2	Manual Calculation of Analytical Hierarchy Process (AHP)	28
3.6	Conclusion	29

<b>4</b>	<b>RESULTS AND DISCUSSIONS</b>	<b>30</b>
4.1	Introduction	30
4.2	Respondent Profile	31
4.2.1	List and Type of Company	31
4.2.2	Education Level	33
4.2.3	Working Experience	34
4.2.4	Involvement in Highway Development	35
4.2.5	Level of awareness on Green Development	37
4.2.6	Involvement in Green Development	38
4.3	Regional Material	40
4.3.1	Local Material	40
4.3.2	Earthwork Balance	42
4.3.3	Average Index Value/Mean Analysis	44
4.4	Respondent Level of Agreement on Application of Regional Material	44
4.4.1	Effect of Education Level	45
4.4.2	Effect of Working Experience	47
4.4.3	Effect of Involvement in Highway Development	49
4.4.4	Effect of Awareness Level on Green Development	51
4.4.5	Effect of Involvement in Green Development	53
4.4.6	Regression and Correlation	55
4.5	Manual Computation of Analytical Hierarchy Process (AHP)	56
4.6	Conclusion	59



<b>5</b>	<b>CONCLUSION</b>	<b>60</b>
5.1	Introduction	60
5.2	Conclusion	60
5.3	Recommendation	61
	<b>REFERENCES</b>	<b>62</b>
	<b>APPENDIX</b>	<b>65</b>

## LIST OF TABLES

<b>TABLE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	Categories and score point (Greenroads Manual, 2011)	10
2.2	Criteria and score point under material and resources (Greenroads Manual, 2011)	11
2.3	List of categories for assessment (GreenPave rating system, 2010)	12
2.4	Local materials used in highway construction	17
2.5	Major components of construction costs	18
4.1	Name of company	32
4.2	Type of company	32
4.3	Frequency of education level	33
4.4	Frequency of working experience	34
4.5	Respondent involvement in highway development	36
4.6	Respondent level of awareness on green development	37
4.7	Respondent involvement in green development	38
4.8	Level of agreement on local material	40
4.9	Level of agreement on earthwork balance	42
4.10	Average Index of regional material	44
4.11	Factors that affect regional material	55
4.12	R <sup>2</sup> value	55
4.13	Significant values of the relationship among the variables	56
4.14	Level of agreement	57
4.15	The weightage of regional material	57
4.16	Frequency of regional material	57
4.17	Scoring point for regional material for each company	57
4.18	Standard deviation value	58

4.19	Range of cumulative score	58
4.20	Formation of classes into five level of agreement	58

## LIST OF FIGURES

<b>FIGURE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
1.1	Economy, environment and society aspects in sustainable development	1
3.1	General process in study	21
3.2	Steps in conduct the methodology	23
3.3	The opening page of SPSS	25
3.4	The general form of input data	26
3.5	Set of data in variable view	27
3.6	The list of data from the survey study	27
4.1	Percentage of education level	33
4.2	Percentage of working experience	35
4.3	Percentage of involvement in highway development	36
4.4	Percentage of awareness on green development	37
4.5	Percentage of involvement in green development	39
4.6	Percentage of agreement on local material	41
4.7	Percentage of agreement on earthwork balance	43
4.8	Level of agreement based on education level for local material	45
4.9	Level of agreement based on education level for earthwork balance	46
4.10	Level of agreement based on working experience for local material	47
4.11	Level of agreement based on working experience for earthwork balance	48
4.12	Level of agreement based on involvement in highway development for local material	49

4.13	Level of agreement based on involvement in highway development for earthwork balance	50
4.14	Level of agreement based on level of awareness on green development for local material	51
4.15	Level of agreement based on level of awareness on green development for earthwork balance	52
4.16	Level of agreement based on involvement in green development for local material	53
4.17	Level of agreement based on involvement in green development for earthwork balance	54

**LIST OF SYMBOLS**

<b>SYMBOL</b>	<b>DESCRIPTION</b>
$a_i$	Class on every frequency data
$x_i$	Frequency of respondents
$i$	Level of agreement 1 to 5
$R$	Regression
$R^2$	R square
CS	Cummulative score
Mean CS	Mean cumulative score
SD	Standard deviation

**LIST OF APPENDICES****APPENDIX****TITLE**

A

Sample of questionnaires in Kuala Lumpur area

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

The realisation of the importance of sustainable and eco-friendly constructions has led to the development of green technology. Sustainable development has been defined by the United Nations as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). Sustainability gives an attention to maintaining a balance on environmental, economic, and societal aspects in the construction. The approach of sustainable construction and with its underlying principles provides a comprehensive guide to enable the construction players to be more responsible to the environmental protection needs without neglecting the social and economic needs in striving for better living (Abidin and Jaapar, 2007).

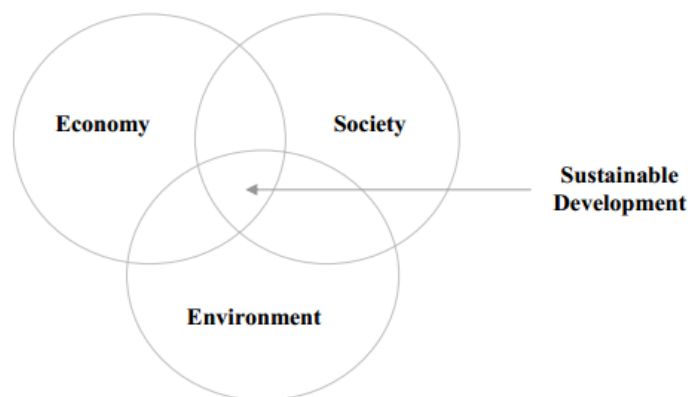


Figure 1.1: Economy, environment and society aspects in sustainable development



In the construction of infrastructures such as highway, the main aim is to produce structures that improve the quality of human life and at the same time it protects the environment efficiently and profitably. The construction is considered as sustainable if it covers the aspects that enhance quality of life and offer customer satisfaction, offer flexibility and the potential to cater for user changes in the future, provide and support desirable natural and social environments, and make sure to maximise the efficient use of resources.

One of the major elements in this new approach is the effort to have green highway. In order for the highway to be categorized as 'green', a standard measurement is required. This method of evaluation is based on score rating system. The development of sustainability rating systems is one indicator of the increased focus to address sustainability within the built environment (Thompson and Bashford, 2011). There are examples of rating systems that are already implemented elsewhere specifically for highway construction projects such as Greenroads, GreenLITES and GreenPave rating system. Green technology promises a sustainable environment towards a better life.

## **1.2 Background of Study**

The development leads us to have a proper living style where the function of road cannot be denied. It is impossible to eliminate the need for roads and roadway improvements any time soon. Therefore, it is best for upcoming improvements are done as sustainably as possible. Higher concern about this matter among the experts in road construction, they start to introduce rating system in all practices.

Compared to most developed countries, Malaysia has not produced its own green highway index. That means we are still using the conventional approaches that may have negative impacts to the environment. Malaysia has only developed the Green Building Index (GBI) for sustainable building and development practices. It has been developed specifically for the Malaysian tropical weather, environmental and developmental context, cultural and social needs (Green Building Index

Manual). However, there is no green highway index established yet to focus on regional materials. Therefore, a study is needed to provide the info that leads to green index according to the situation in this country.

### **1.3 Objectives of Study**

The aim of this study is to provide green index assessment which focuses on regional materials. This can be achieved by the following objectives:

- 1) To identify the criteria of regional materials used in highway,
- 2) To determine the score value for the regional materials, and
- 3) To find the relevancy in applying local material and earthwork balance in Kuala Lumpur

### **1.4 Scope of Study**

The evaluation of green index assessment for materials and resources consists of criteria such as recycled and reused materials, sustainable resources, waste management, and green products. These studies only cover a small scope of sustainable resources by using regional materials. The survey is conducted to evaluate the application of waste minimization towards sustainability development in road construction. The sub-criteria of regional material are being observed and the data were taken in areas around Kuala Lumpur. The studies required the respondents' knowledge and experience in order to give suggestions related to green highway assessment.

## **1.5 Importance of Study**

Study on regional materials is a part of green highway. By using regional materials, it means that the products used contain raw materials that are locally harvested, extracted or recovered. It also includes the element of earthwork balance which is under the primary stage in constructing the highway. An application of this material at site contributes to reduce transportation of vehicle (materials delivery), reduce energy consumption, reduce gas emission and as a result it will reduce the total cost of project. Not just that, it also improves local economic by using local material due to less demand of new material from supplier.

## REFERENCES

1. Abidin. N. Z. and Jaapar. A. (2007). Sustainable Concept Awareness in Malaysia Construction Practices.
2. Al-Qutaish. R. E., Muhairat. M. I., and Al-Kasasbeh. B. M. (2009). The Analytical Hierarchy Process as a Tool to Select Open Source Software. Department of Software Engineering Al-Zaytoonah University of Jordan and Faculty of Information Technology Applied Science University, Jordan.
3. Beceric. B. (2005). Innovative Use of Constuction Project Extranets to Facilitate Project Collaboration and Management. 3<sup>rd</sup> International Conference on Innovation in Architecture, Engineering and Management, Rotterdam.
4. Brundtland, G. (1987). Our Common Future. (A/42/427). Report of the World Commission on Environment and Development. United Nations General Assembly.
5. Bryce. J. M., 2008. Developing Sustainable Transportation Infrastructure: Exploring the Development and Implementation of a Green Highway Rating System. University of Missouri, ASTM WISE Intern.
6. Clark. M., Paulli. C., Tetreault. Z., Thomas. J. (2009). Green Guide for Roads Rating System. Worcester Polytechnical Institute.
7. Chew. E P, Goh. C J, and Fwa. T F. Simultaneous optimization of horizontal and vertical alignments for highways. Transportation Research Part B: Methodological, 23(5):315–329, 1989.
8. FEHRL. (2008). New Road Construction Concepts: Towards Reliable, Green, Safe & Smart and Human Infrastucture in Europe. Sixth Framework Programme of the European Union.

9. Green Building Index Manual (2011). GBI Assessment Criteria for Township.
10. Green Building Index Manual (2009). GBI Assessment Criteria for Non-Residential New Construction (NRCR)
11. Green Building Index Manual (2011). GBI Assessment Criteria for Residential New Construction (RNC)
12. Greenroads Manual v1.5 (2011). Seattle, WA: University of Washington.
13. GreenLITES Project Design Certification Program (2008). Recognizing Outstanding Leadership In Transportation and Environmental Sustainability.
14. Koch. V. R. (2010). Optimizing Earthwork Block Removal in Road Construction. B.Sc. Hons., The University of British Columbia, 2008. The University of British Columbia (Okanagan).
15. LEED for New Construction Version 2.2 (2007). U.S. Building Council.
16. Mallick. R. B. & Veeraragavan. A (2011). Sustainable Pavement Engineering.
17. Ministry of Transportation, Ontario (2010). GreenPave: Ontario's First Pavement Sustainability Rating System. Road Talk, Winter 2010, Vol. 16, Issue 1.
18. Muench, S.T., Anderson, J.L., Hatfield, J.P., Koester, J.R., & Söderlund, M. et al. (2011). Greenroads Manual v1.5.(J.L. Anderson, C.D. Weiland, and S.T. Muench, Eds.). Seattle, WA: University of Washington.

19. Mulmi. A. D., (2009). Green Road Approach in Rural Road Construction for the Sustainable Development of Nepal. Department of Roads Ministry of Physical Planning and Works, Government of Nepal Babarmahal, Kathmandu, India.
20. Palcic. I and Lalic. B (2009). Analytical Hierarcy Process as a Tool for Selecting and evaluating Projects. Faculty of Mechanical Engineering, University of Maribor, Slovenia and Faculty of Technical Science, University of Novi Sad, Trg Dositeja Obradovica, Novi Sad, Serbia.
21. Sathe. N. S., Dangar R. P., Solanki. R. V. and Modi K. B. (2011). Recent Trends in Transportation Projects: The Need For Economically Viable & Eco-Friendly Road Construction. B.V.M. Engineering College, V. V. Nagar, Gujarat, India
22. Silivarajoo. P. (2010). Green Technology: A Driver towards Sustainable Development. Principal Assistant Secretary Green Technology Sector Ministry of Energy, Green Technology and Water.
23. Thompson. J. D. and Bashford. H. H. (2011) Sustainability Strategies for Highway Construction: A Case Study of ADOT's Piestewa SR51 HOV Widening Project. Arizona State University Tempe, Arizon.
24. Virginia Green Highway Initiative (2012). <http://www.vtti.vt.edu/vghi.php> accessed by 09/8/2012
25. Yahya. M. A. and Ng. C. P. (2010). Awareness in Innovative Highway Construction in Malaysia.